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Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulations for Gasoline Fueled Motor Vehicles. Volume 2. Additional Analysis of Onboard Controls

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Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulations for Gasoline-Fueled Motor Vehicles —

Volume II Additional Analysis of Onboard Controls

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See also Volume 1, PB87-221677.

The second volume supplements the first volume of the draft Regulatory Impact Analysis in fulfilling the objectives of Title 3 - Executive Order 12291 as they apply to the proposed onboard rulemaking. It provides a summary of the more extensive support analyses of onboard costs and air quality benefits that were prepared in the course of developing the proposed regulations. Alternatives to the proposed regulations are considered in Volume I. More specifically, the report summarizes the economic impact of the proposed rulemaking. It identifies the fixed and variable costs to manufacturers for systems development, certification, facility modifications, and emission control hardware. Chapter 3 summarizes the air quality benefits of the proposed rulemaking.

KEYWORDS: *Gasoline, *Air pollution control, *Regulatory impact analysis.

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Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulations for Gasoline-Fueled Motor Vehicles —

Volume II
Additional Analysis of Onboard Controls

OFFICE OF AIR QUALITY PLANNING AND STANDARDS
AND
OFFICE OF MOBILE SOURCES

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Washington, DC 20460

July 1987

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1.0 INTRODUCTION

This second volume (Volume II) supplements the first volume of the draft Regulatory Impact Analysis in fulfilling the objectives of Title 3 - Executive Order 12291 as they apply to the proposed onboard rulemaking. It provides a summary of the more extensive support analyses of onboard costs and air quality benefits that were prepared in the course of developing the proposed regulations. Alternatives to the proposed regulations are considered in Volume I.[1]

More specifically, following this introduction (Chapter 1), Chapter 2 of this volume summarizes the economic impact of the proposed rulemaking. It identifies the fixed and variable costs to manufacturers for systems development, certification, facility modifications, and emission control hardware. It also addresses costs to consumers in terms of both first price increase for hardware and operating costs or savings. Finally, the chapter summarizes aggregate costs of the proposed regulations to the nation by year incurred, and the socioeconomic impact of the proposed rulemaking. The latter category includes a brief discussion of the impacts on the financial status of manufacturers and component vendors, effects on sales and employment in the automotive and petroleum industries, effects on energy usage, balance of trade, and on particular segments of the economy.

Chapter 3 summarizes the air quality benefits of the proposed rulemaking. Beginning with a brief characterization of refueling emissions potentially controllable by an onboard control strategy, the chapter goes on to analyze the effect of refueling emissions control on ambient ozone levels in current non-attainment areas, i.e. those areas now in violation of the National Ambient Air Quality Standards for ozone. The direct health effects of ozone have been fully documented in other EPA publications and so they are not included in this analysis.

REFERENCES FOR CHAPTER 1

1. Draft Regulatory Impact Analysis: Proposed Refueling Emission Regulations for Gasoline-Fueled Motor Vehicles -- Volume I - Analysis of Gasoline Marketing Regulatory Strategies, U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards and Office of Mobile Sources, EPA-450/3-87-001a, July 1987.

2.0 ECONOMIC IMPACT

I. Introduction

This chapter assesses the economic impact of onboard control of refueling emissions in terms of the costs to manufacturers, costs to the consumer, total cost to the nation and the overall socioeconomic impact of the proposed regulations. The purpose of this chapter is to summarize and assemble into one comprehensive analysis those cost elements that have been developed in greater detail than in "Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry - Response to Public Comments" (hereafter referred to as the "response to public comments document"), and other support documents.[1]

In addition to controlling refueling emissions, properly designed and tested onboard control systems also have the potential to control excess evaporative emissions. However, other approaches to controlling excess evaporative emissions are being evaluated separately, so this analysis will focus primarily on the costs of refueling emissions control alone. Specifically, the costs and credits involved in onboard control of refueling emissions described here are incremental to vehicle-based excess evaporative control costs.

This chapter is organized into four sections (1) costs to manufacturers, i.e., systems engineering costs, certification costs, facility modifications and hardware costs, (2) costs to the consumer, including first price increase and operating costs or savings, (3) aggregate costs to the nation, by year incurred, and (4) socioeconomic impacts of the regulations. The latter would include any effects the proposed regulations might have on manufacturers' or vendors financial status, effects on sales and employment in the automotive and petroleum industries, and effects on energy usage, balance of trade, or on particular segments of the economy.

Data from a wide variety of sources were utilized to develop the cost estimates summarized in this chapter. The primary sources for the hardware cost estimates at the vendor level are studies done in 1978 and 1983 by Leroy H. Lindgren.[2,3] Retail Price Equivalent (RPE) markups, used to calculate costs to the consumer from vendor costs, were developed by an EPA contractor.[4] These works have been supplemented where appropriate by other EPA contract studies, comments on the draft gasoline marketing study from the automotive and petroleum industries, supplier quotations, trade publications and previous estimates from EPA regulatory support analyses. Most of the estimates of vehicle miles traveled (VMT) and fuel consumption data used in assessing operating costs were obtained from EPA's MOBILE3 emission factors and fuel consumption models. Additional vehicle usage data came from the Department of Commerce "Truck Inventory and Use Survey" (TIUS) and an SAE paper on fuel economy done by EPA.[5,6]

Vehicle sales estimates are based on the Data Resources Incorporated 25-year "Trendlong" projections.[7] The dieselization rates applied to these projections to obtain gasoline-fueled vehicle sales estimates are from the MOBILE3 model.

In determining costs to the industry, consumers, and aggregate costs to the nation, various cost elements must be amortized over different periods of time, and in portions of the analysis costs must be discounted to reflect the time value of money. Systems engineering and certification costs, for example, are relatively short term and are likely to be incurred and recovered early in the regulation implementation period. These costs will therefore be amortized over a five year period 1990-1994, assuming a 1990 implementation date for the proposed regulations. The other fixed costs, those for modification and construction of testing facilities, are longer-term and will be amortized over a ten year period 1990-1999. Variable costs will be aggregated over the initial five-year period to show the highest annual costs and will be discounted to reflect the time value of money, where necessary. The standard ten percent discount rate will be used, and all fixed costs will be amortized at a 10 percent interest rate. All costs are expressed in 1986 dollars.

II. Costs to Manufacturers

Costs to manufacturers can be divided into two general categories, fixed and variable costs. Fixed costs represent capital expenditures that must be made before production of emission control components can begin. As such, they are relatively independent of production volumes. These costs include systems engineering costs, certification costs and facilities modifications. Variable costs represent the vendor cost of the necessary emission control hardware. They are directly dependent on production volume and are expressed on a per vehicle basis. The fixed costs will be amortized and added to variable costs to provide a total unit cost to the manufacturer.

The basic source for this section is the response to public comments document.[1] For additional detail on both fixed and variable costs, the reader is referred to this document.

A. Fixed Costs

As stated above, the fixed costs involved in onboard control of refueling emissions include systems engineering and certification costs, and the cost of test facilities modifications. These costs can be expected to vary somewhat between vehicle classes, however light duty vehicles (LDVs) and light duty trucks (LDTs) have the same certification procedures

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and quite similar fuel systems and can therefore be grouped together. Heavy-duty gasoline vehicles (HDGVs) have similar, but larger, systems and different certification procedures. Estimating costs for HDGVs requires some different analysis than that needed for LDVs and LDTs.

1. Light Duty Vehicles and Light Duty Trucks

Systems engineering costs are those incurred in developing an onboard system that is integrated with the other related vehicle/engine systems. This includes incorporation of the onboard system into other vehicle/engine systems (e.g. fuel system, packaging) as well as consideration of safety and other emission control requirements. In some cases this is a straightforward engineering design problem, in others such as vehicle safety or emissions control, it involves not only design, but also follow-on testing and evaluation.

At this point EPA has little data on which to base a firm estimate of the systems engineering costs. Costs involved would generally include engineering design and development, procurement and modification of prototype hardware and test vehicles, and the actual testing and evaluation of the systems. The above mentioned safety testing and evaluation would also be included. EPA briefly examined these latter costs and concluded that the cost for ensuring compliance with the applicable fuel system safety provisions would be about $34,000 per body configuration, or approximately $6.9 million fleetwide.[8] Since the number of body configurations is roughly equal to the projected number of refueling families, this cost can easily be included in the total systems engineering cost per family. Accordingly, in the response to public comments document, EPA estimates a total systems engineering cost for LDVs and LDTs (including safety costs) at about $146,000 per refueling family (assumed to be similar in number to the current evaporative emissions family). Multiplying by the projected number of families (approximately 140 LDV and 65 LDT) results in an estimated cost of $20.4 million for LDVs and $9.5 million for LDTs. Amortizing these costs for five years at 10 percent per year and dividing by projected sales during the period provides an amortized cost per vehicle of $.45 per LDV and $.69 per LDT, including $.12 per vehicle for fuel system safety compliance.

Certification costs include the costs of vehicle buildup, mileage accumulation for LDVs and LDTs on durability and emission data vehicles, and emissions testing for durability and emission data vehicles. The EPA estimated cost per family from the response to public comments document is $181,000 for durability vehicles and $28,000 for emission data vehicles. Although a total recertification would likely be necessary because of the refueling regulations, the estimated 10 percent of the fleet that normally undergoes certification each year

regardless of new standards must be deducted to determine the net cost of the refueling regulations. Multiplying the cost per family by 90 percent of the projected LDV and LDT families yields a certification cost of approximately $26 million for LDVs and $11 million for LDTs. The amortized cost per vehicle is $.61 for LDVs and $.77 for LDTs.

Systems engineering and certification efforts will require some expansion of and/or improvement to manufacturers' testing facilities in order to accommodate the additional testing required. Comments submitted by the Motor Vehicle Manufacturers Association (MVMA) contained an estimate of $734,000 per manufacturer for additional equipment and testing space.[9] Absent any other reasonable estimates of the requirements, the response to public comments document uses this figure to project the facilities modifications that would be required. Although it is unlikely that all 35 LDV/LDT manufacturers would incur this entire expenditure, it is possible that some larger manufacturers would have to spend even more than this amount. To be conservative, then, EPA will assume that all manufacturers will make the above investment in additional facilities, for a total industry cost of approximately $26 million. This results in an amortized cost per vehicle of approximately $.30.

2. Heavy-Duty Gasoline Vehicles

Due to the wide range of HDGV sizes and applications, it is necessary to first categorize the HDGV fleet in terms of key fuel/vapor system parameters (vehicle length, chassis design, number/size of fuel tank(s), etc.) before manufacturer costs can be determined. The most convenient breakdown of the HDGV fleet is into weight classes based on gross vehicle weight (GVW) rating. While the HDGV fleet is traditionally broken down into seven GVW classes (IIb-VIII) insufficient data was available at the time of the response to public comments document[1] to accurately describe the HDGV fleet in terms of seven different groups. It was known, however, that about ninety percent of all HDGVs fall into one of three weight classes: Class IIb (8501-10,000 lbs GVW), Class VI (19,501-26,000 lbs GVW), and Class VII (26,001-33,000 lbs GVW). It was also known that about 75 percent of these vehicles fall into Class IIb. Therefore, a relatively simplified analysis was performed which assumed that 75 percent of all HDGVs can be classified as Class IIb trucks, and all remaining HDGVs can be classified as Class VI vehicles since Class VII vehicles are quite similar to Class VI vehicles. Finally, it should be noted that Class IIb trucks are essentially heavy LDTs and can benefit directly from the transfer of LDT technology.

Systems engineering costs for the Class IIb vehicles should be the same as for LDTs, i.e., $.69/truck, since they are all made by LDT manufacturers and can thus take advantage

of the LDT work. In fact, some manufacturers may choose to certify part or all of their Class IIb trucks as LDTs.

Class VI HDGV refueling emissions are likely to present additional control problems. The emission loads are likely to be greater, due to the larger fuel tanks that are typically found on these vehicles. Also, most of the heavier HDGVs currently have open loop carbureted fuel systems, which would have more difficulty with purge control than the closed-loop fuel systems with electronic engine controls that are more common on LDVs and LDTs and are expected on many Class IIb vehicles. Some additional purge control systems engineering is thus likely to be required for these vehicles. Conversely, it should be noted that the current HC and CO exhaust emission standards for these vehicles are not as stringent as those that apply to the Class IIb HDGVs. In the response to public comments document, EPA estimates a cost of $1.50 per vehicle to cover development of these control systems. On a fleet weighted basis, the amortized costs of all HDGV classes is $0.89 per vehicle. Equivalent total systems engineering costs can be obtained by summing the net present value of the $.69 Class IIb cost and the $1.50 Class VI cost multiplied by the respective projected sales for the two classes for the first five years of the regulation. This would equate to a total HDGV systems engineering cost to manufacturers of about $1.4 million.

Control of HDGV refueling emissions would entail recertification to the exhaust and evaporative emission standards in addition to refueling. Exhaust emission recertification would be necessary due to the new requirement that evaporative/refueling emission control canister(s) be connected to the engine during testing. Evaporative emission recertification would be necessary due to the test procedure changes and the potential interdependence between the evaporative and refueling control systems.

Exhaust emissions recertification is estimated to cost $200,000 per family. This entails both durability assessment and three emission data engines. For 1986, HDGV manufacturers certified 8 families using 23 emission data engines. Total exhaust emission recertification costs including durability assessment are estimated at $1.6 million dollars.

Evaporative emission recertification costs are a bit more difficult to estimate since abbreviated certification procedures apply to Classes IIb through VI HDGVs and certification is by engineering evaluation for the heavier HDGVs. Using the development costs presented in the original HDGV RIA, certification costs are estimated at $31,000 per evaporative family/system combination. In 1986, 23 family/system combinations were certified. Using these figures, total evaporative emission certification costs are estimated at $713,000.

Even though abbreviated certification procedures have been proposed for HDGV refueling, some costs would still be incurred for durability assessment and demonstration of system performance on emission data vehicles. However, these costs would be incremental to those incurred during system development and exhaust and evaporative emission recertification. Durability assessment is estimated to cost a nominal $50,000 per manufacturer over those costs incurred for exhaust and evaporative recertification, and emission data vehicle testing is estimated to cost $9000 per family/system combination for testing and mileage accumulation. Assuming three primary HDGV manufacturers and the same number of refueling and evaporative family/system combinations (i.e. 23) the total certification for refueling is estimated to be $357,000.

Summing the estimated costs for exhaust, evaporative, and refueling certification, the total industry cost is estimated at $2.67 million dollars. Assuming these costs are incurred in the year prior to the new standard and amortized over vehicles sold in the 5 year period 1990-1994, the per vehicle certification cost is $2.00.

The final fixed cost to manufacturers of HDGVs is for modification of and improvements to test facilities. It is anticipated that the requirements for Class IIb vehicles will be essentially the same as those required for LDTs; the same facility may in fact serve both vehicle classes. Class VI vehicles will also require new or modified facilities for certification. Thus, while the additional facility requirements may be minimal, the $.30 per vehicle estimated for LDVs and LDTs is also extended to HDGVs. This provides an additional $710,000 to cover any incidental modifications that may be required for HDGV facilities.

3. Summary

In summary, the projected manufacturers' fixed costs for LDVs, LDTs, and HDGVs are just under $98 million. These costs are divided between the various vehicle classes for systems engineering, certification and facilities modifications as shown in Table 1. Table 1 also shows these fixed costs on an amortized per-vehicle basis.

B. Variable Costs

Emission control hardware is the primary variable cost to the manufacturers. Refueling control hardware costs for individual components are relatively the same for any vehicle class/subgroup, but total system costs vary somewhat depending on the type of control system, the number of fuel tanks, and the vehicle fuel tank capacity. A brief description of the onboard control system and a summary of the individual

Table 1

Fixed Costs to Manufacturers
(Millions of Dollars)

	LDV	LDT	HDGV	Total
Systems Engineering	20.4	9.5	1.4	31.3
Certification	26.0	11.0	2.7	39.7
Facility Mods	17.9	8.1	0.7	26.7
Total	64.3	28.6	4.8	97.7

Amortized Costs per Vehicle
(Dollars)

	LDV	LDT	HDGV
Systems Engineering	0.45	0.69	0.89
Certification	0.61	0.77	2.00
Facility Mods	0.30	0.30	0.30
Total	1.36	1.76	3.19

component costs is given below. This is followed by a discussion of the key factors which can cause the costs to vary and a summary of the control system costs used in the analysis.

As described in the Technological Feasibility portion of the gasoline marketing study, an onboard system is comprised of a number of new components and modification of several existing components. These are described briefly below:

1. Fillpipe Seal - Used to prevent gasoline vapor from escaping to the atmosphere. Liquid or mechanical seal approaches are possible. This analysis assumes all vehicles will use liquid seals, except the large HDGVs (Class VI) which may use mechanical seals. A pressure relief device may be required for mechanical seals.

2. Fill Limiter - A device inside the tank used to close the refueling vapor line when the tank is full, eventually causing actuation of of automatic shut-off on the fuel nozzle.

3. Vapor Line Closure Valve - A valve used to close the vapor line during normal vehicle operation. This is a key component in rollover protection. Electronic or mechanical approaches are possible.

4. Liquid/Vapor Separator - Required to decrease the emission load to the canister and improve canister durability by returning entrained liquid fuel droplets to the fuel tank.

5. Vapor and Purge Lines - Hoses to route refueling vapor to the charcoal canister and purged vapor to the vehicle fuel system. Net cost depends on canister location and whether the system is integrated or separate from the evaporative control systems.

6. Charcoal Canister - Serves as vapor storage device. Cost and size vary with fuel tank size and whether the control system is integrated or separate.

7. Packaging - Hardware or vehicle modifications to accommodate canister and other hardware on the vehicle. Costs vary depending on vehicle size and type. These costs are amortized over five years.

8. Modifications - Minor modifications will be necessary to the fuel tank and vehicle purge system. Fuel tank modifications will be needed to accommodate the liquid seal and fill limiter. Purge system modifications will be needed to efficiently purge the canister while controlling exhaust emissions. These costs are amortized over five years of production.

On a per vehicle basis, three other factors may affect the total cost of the refueling emission control hardware. These include the basic system approach, the number of fuel tanks, and the capacity of the fuel tanks.

Three basic control systems approaches may be used; integrated, partially integrated, and separate. The integrated system uses one canister to control both evaporative and refueling emissions. The partially integrated system collects diurnal evaporative and refueling emissions in one canister and uses a separate canister for capturing hot soak emissions. The third approach, the completely separate system, captures all evaporative emissions in one canister and all refueling emissions in another.

EPA expects that all fuel injected vehicles will utilize fully integrated systems due to the cost advantage and the low level of non-fuel tank hot soak emissions. Carbureted vehicles may use partially integrated or separate systems due to the need to deal with hot soak evaporative emissions. However, EPA expects most manufacturers will opt for partially integrated systems to take advantage of the available cost savings.

By 1990, when these regulations are assumed to take effect, current projections are that approximately 88 percent of all LDVs and LDTs are expected to be fuel injected and 12 percent carbureted. Class IIb HDGV fuel systems are likely to follow the same split as LDTs. The majority of the heavier HDGVs (Class VI) are assumed to remain predominantly carbureted. Thus 88 percent of LDVs, LDTs and Class IIb HDGVs are expected to use integrated systems and the remaining 12 percent of these vehicles classes are expected to use partially integrated systems. Essentially all of the heavier HDGVs are assumed to use either partially integrated or separate systems.

On a per vehicle basis, onboard hardware costs also depend on whether a vehicle has single or dual fuel tanks. Hardware costs for dual fuel tank vehicles are essentially twice those of single tanks because each fuel system requires the necessary control hardware. Dual tank vehicles could use any of the three control system approaches discussed above, and EPA assumes that the mix of these control approaches will be the same as described above for both single and dual tank vehicles. The fractions of dual tank vehicles used in this analysis are shown below. These essentially reflect current conditions.

LDV	0%
LDT	20%
HDGV:	
Class IIb	20%
Class VI	15%

While most individual onboard hardware component costs will not vary among the vehicle models, the cost of the charcoal canister for any given vehicle model will vary depending on the capacity of the fuel tank. The cost of a refueling emissions control canister is a function of the required control system capacity which in turn depends upon the size of the fuel tank. EPA estimated fleet average fuel tank sizes for the three vehicle classes/subgroups based on a minimum driving range and the fuel economy improvements that are expected to occur between 1990 and 2000. The projected fuel tank capacities used in calculating canister costs for the three vehicle classes/subgroups are shown in Table 2.

Based on this information regarding refueling control hardware and those factors which influence total per vehicle cost, Tables 3 and 4 present onboard costs for LDVs, LDTs and HDGVs. These are manufacturer (vendor level) costs and do not reflect manufacturer or dealer markups for overhead and profit. For sake of completeness, the amortized fixed costs discussed previously are also listed. It should be noted that the costs presented in Tables 3 and 4 are incremental to the cost of current evaporative emissions systems.

As can be seen from Tables 3 and 4, costs vary with time to reflect both the different amortization periods for fixed costs and changing canister sizes due to projected fuel economy improvements. Three distinct cost periods can be identified for LDVs, and LDTs, and HDGVs: 1990-94, 1995-99, and 2000 and beyond. For the sake of brevity, only the total costs are shown for the years after 1994 for all vehicle classes. The cost differences are based on the following assumptions. For all vehicles, systems engineering and certification costs are assumed to be fully amortized during the first 5 years, i.e. by 1994, and are not reflected thereafter. Vehicle modifications (i.e. tank and purge system modifications and packaging) costs would also disappear after 5 years for LDVs, LDTs and Class IIb HDGVs, as car and truck designs begin to incorporate onboard controls from the initial design inception. Class VI HDGVs are assumed to have no packaging costs and so these are not reflected in the 1990-94 initial cost estimates. Tank and purge system modification costs would also drop out after five years for HDGVs, just as they do for LDVs and LDTs. For LDVs, LDTs, and HDGVs, facility modifications represent a longer-term investment and are assumed to be fully amortized after 10 years. Therefore they are not included after 1999.

Projected fuel economy improvements have been averaged for each of the three periods to determine canister size requirements for LDVs and LDTs. These are also reflected in the decreasing costs for each period. Fuel economy differences are not reflected in long-term HDGV costs, since the projected improvements are slight and have a minimal effect on system costs.

Table 2

Projected Fuel Tank Capacity By Vehicle Class
(Gallons)

Vehicle Class	5 Year Period 1990-94	1995-1999	2000+
LDV	12	11	10
LDT			
Single Tank	16	16	15
Dual Tank	33	32	29
HDGV			
IIb-Single	20	20	20
IIb-Dual	40	40	40
VI-Single	30	30	30
VI-Dual	80	80	80

Table 3

Manufacturer Costs of Onboard Emission Control Components
Light Duty Vehicles and Light Duty Trucks

	LDV		LDT - Single Tank		LDT - Dual Tank	
Category	Integrated	Part Int/Sep	Integrated	Part Int/Sep	Integrated	Part Int/Sep
1990-94						
Hardware	13.24	15.17	14.58	16.54	32.39	34.21
Veh. Mods	1.07	1.97	1.07	1.97	2.39	3.44
Subtotal	14.31	17.14	15.65	18.51	34.78	37.65
Amortized Fixed Costs	1.36	1.36	1.76	1.76	2.11	2.11
Total	15.67	18.50	17.41	20.27	36.89	39.76

Class Weighted Avg.	LDV	LDT-ST	LDT-DT	All LDT
1990-94	16.01	17.75	37.23	21.65
1995-99	14.00	15.51	33.82	19.17
2000 +	12.87	14.29	32.08	17.85

Table 4

Manufacturer Costs of Onboard Emission Control Components
Heavy Duty Gasoline Vehicles

	CL. IIb HDGV		CL. VI HDGV	
Category	Single Tank	Dual Tank	Single Tank	Dual Tank
1990-94				
Hardware	15.66	35.43	28.91	62.18
Veh. Mods	1.25	2.00	0.75	1.50
Subtotal	16.91	37.43	29.66	63.68
Amortized Fixed Costs	2.99	2.99	3.80	3.80
Total	19.90	40.42	33.46	67.48

Class Weighted Avg:	IIb	VI	All HDGV
1990-94	24.00	38.56	27.64
1995-99	19.91	34.16	23.47
2000 +	19.61	33.86	23.17

As was mentioned previously, properly designed and tested onboard control systems also have the capacity to control the excess evaporative emissions caused by the higher volatility of commercial fuels. However, these excess evaporative emissions could be controlled by increasing the RVP of the fuel used in exhaust and evaporative emissions certification testing to the in-use level of 11.5 psi, in which case manufacturers would be forced to improve their current emission control systems. Thus it is appropriate to evaluate onboard refueling control costs incremental to excess evaporative emission control costs. Calculating the costs of onboard controls incremental to improved evaporative systems requires the subtraction of the incremental costs of the improved evaporative systems from the onboard costs presented in Tables 3 and 4. This is done in Table 5 for LDVS, LDTs, HDGVs. The cost of these improved systems is taken from EPA's recent study of gasoline volatility and vehicle HC emissions.[10] For the sake of brevity only a single cost is shown for each vehicle class. This cost is a weighted average based on the distribution of configurations discussed earlier.

III. Costs to the Consumer

The cost of the proposed regulations to the consumer can be divided into two general categories: first price increase and operating costs. The first price increase consists of hardware costs, amortized manufacturer fixed costs and the retail price equivalent (RPE) markups. The RPE reflects the various overhead and profit markups that are added to the vendor cost of a the onboard system at the manufacturer and dealer levels. The second category, operating costs, consists of maintenance and in-use inspection costs, if any, plus any change in total lifetime fuel costs due to increased or decreased fuel consumption rates. Each of these is discussed below, followed by an estimate of the net lifetime consumer cost.

A. First Price Increase

The total first price increase to the consumer consists of the manufacturer's cost per vehicle developed in the previous section, including amortized fixed costs, multiplied by an RPE markup factor of 1.26 for LDVs and LDTs and 1.27 for HDGVs. These markup factors represent industry averages and were developed by an EPA contractor using available financial data for the domestic auto and truck manufacturers and their dealers.[4] Data covering a ten year time span were used in the determination to dampen the effects of the business cycle. The markup factor includes corporate overhead and profit plus dealer profit and other expenses for interest and sales commissions. No dealer overhead is included, since the addition of emission control components should not increase the dealer's cost for storing or selling his vehicles. Hardware

Table 5

Onboard Hardware Costs to Manufacturers
(Incremental to Costs for Control of
Excess Evaporative Emissions)

	LDV	LDT	HDGV
1990-94 Hardware cost[1]	$16.01	$21.65	$27.64
Less: excess evap. cost	-2.25	-2.98	-3.28
Incremental cost[2]	13.76	18.67	24.36
1995-99 Hardware cost[1]	14.00	19.17	23.47
Less: excess evap cost	-1.52	-1.99	-2.70
Incremental cost[2]	12.48	17.18	20.77
2000 + Hardware cost[1]	12.87	17.85	23.17
Less: excess evap cost	-1.52	-1.99	-2.70
Incremental cost[2]	11.35	15.86	20.47

[1] Incremental to cost of current evaporative control systems.

[2] Incremental to cost of improved evaporative control systems capable of controlling excess evaporative emissions.

costs and amortized costs for certification and facilities modifications are marked up using these factors. However, using the markup methodology developed by Lindgren for EPA, systems engineering costs are essentially R&D and are not subject to RPE markups, but rather are added to the total cost after the RPE markup has been applied. Table 6 shows the first price increase to the consumer when onboard costs are evaluated incremental to excess evaporative emission control costs.

B. Operating Costs

As discussed in the response to public comments document, an onboard system should not require any additional maintenance over the current evaporative emission control system. Also, no in-use inspections of onboard systems are likely, since evaporative systems are generally not inspected in current programs and tampering rates are relatively low. Therefore, no increases in operating costs related to onboard system maintenance or in-use inspections are expected.

However, some change in lifetime operating costs are expected as a result of the positive fuel consumption benefit realized from the fuel recovery credits. Fuel recovery credits accompany both the recovery of refueling and excess evaporative emissions, but this analysis will address only the refueling emissions which are captured by the onboard system. As was mentioned previously, a properly designed and tested onboard system would also have the capacity to control excess evaporative emissions, but alternative strategies for controlling excess evaporative emissions may reduce or totally eliminate the excess evaporative credit.

The lifetime change in fuel consumption resulting from the recovery of refueling emissions actually is the difference of two effects: the gross recovery credit less the effect of the weight penalty associated with the onboard system. The gross recovery credit is determined by calculating the gasoline equivalent of the total mass of refueling vapors captured, then multiplying this figure by the presumed vapor combustion efficiency. This recovery credit must then be reduced by the fuel economy penalty resulting from the slight weight increase associated with the onboard system. The weight penalty was determined using the estimated weight of an onboard system together with a weight/fuel consumption sensitivity factor.

Using this approach, the net change in fuel consumption in each year of the vehicle life was determined and then multiplied by the value of a gallon of gasoline ($0.98) to get the monetary value of the recovery credit. These values were then discounted at 10 percent to the first year of the vehicle's life to get a monetary value in the same terms as the RPE.

Table 6

Costs to the Consumer[1]
Onboard Refueling Emissions Control

Costs: 1990-94:	LDV	LDT	Dual Tank LDT	Class IIb HDGV	Class VI HDGV
First Price Increase:					
Refueling FPI	17.17	18.39	42.82	26.02	44.29
Less:					
Refueling Credits	(4.24)	(6.50)	(3.35)	(11.70)	(23.10)
Net cost to consumer	$12.93	$11.89	$39.47	$14.32	$21.19
Costs: 1995-1999:					
Refueling FPI	15.71	17.01	40.08	21.86	39.96
Less:					
Refueling Credits	(3.85)	(6.31)	(3.22)	(11.20)	(22.70)
Net cost to consumer	$11.86	$10.70	$36.86	$10.66	$17.26
Costs: 2000 & Beyond:					
Total Refueling FPI	14.29	15.47	37.89	21.48	39.58
Less:					
Refueling Credits	(3.53)	(5.93)	(3.09)	(11.00)	(22.60)
Net cost to consumer	$10.76	$9.54	$34.80	$10.48	$16.98

[1] Minor differences between the costs presented in this table and those presented in the response to public comments document are due to rounding. Costs are incremental to excess evaporative emissions control costs.

This analysis was conducted for the five vehicle classes/subgroups being evaluated here for the three time periods mentioned earlier for the hardware, ie. 1990-1994, 1995-1999, and 2000 and beyond. The results of the analysis are shown in Table 6.

C. Net Consumer Costs

The net lifetime consumer costs for onboard control are shown in Table 6. In this table the costs associated with the first price increase are partially offset by the net present value of the recovery credits. Net costs are shown for the five vehicle class/subgroups and the three time periods mentioned previously.

IV. Aggregate Costs to the Nation

Aggregate costs to the nation include the fixed costs to manufacturers for systems engineering, certification and facility modifications, plus the cost to the consumer for hardware, less the fuel recovery credits. In calculating these costs, the net amounts from Table 6, adjusted to remove the amortized fixed costs, were multiplied by the projected sales shown in Table 7. The 1988-94 aggregate costs are shown in Table 8 (undiscounted) and Table 9 (discounted) by the year they are expected to be incurred. A total discounted cost is also shown for each vehicle class, representing a lump sum payment as of the year the standards are effective. Costs are shown for LDVs, LDTs, HDGVs and a total for all three classes. All costs before the year the standard is assumed to take effect (1990) are for systems engineering, certification, and facility modifications; all costs for 1990 and subsequent years are for hardware costs, less fuel recovery credits. It is assumed that all systems engineering and facility modifications costs will be incurred in 1988 while all certification costs will be incurred in 1989. All of the costs shown in Table 9 are discounted at 10 percent per year to 1990, the first model year of the standard. As shown in the table, the total discounted cost to the nation for the proposed refueling regulations (in 1986 dollars) is about $892 million.

IV. Socioeconomic Impact

The socioeconomic effects of the proposed regulations include any impact they may have on manufacturers' cash flow, sales and employment, energy usage, balance of trade, and on particular groups of individuals or segments of the economy. The overall impact of the proposed regulations on manufacturers' cash flow is expected to be minor. Hardware costs are recouped by the manufacturers during the year they are incurred. With current computerized inventory control systems, manufacturers are not expected to be required to maintain large, expensive parts inventories during the course

Table 7

Projected Gasoline-fueled Vehicle Sales
(Millions of Vehicles)
1990-2000

Year	LDV[1]	LDT[1]	HDGV[2]
1990	11.2	3.71	0.384
1991	11.2	3.68	0.381
1992	11.2	3.64	0.379
1993	11.1	3.56	0.381
1994	11.0	3.47	0.383
1995	10.8	3.35	0.384
1996	10.9	3.40	0.385
1997	11.0	3.43	0.388
1998	11.0	3.45	0.392
1999	11.0	3.46	0.396
2000 +	11.0	3.48	0.400

[1] Based on DRI "Trendlong" Projections, Fall, 1984 Long Term Review, Data Resources, Inc., 1984.

[2] See Reference 11.

Table 8

Aggregate Incremental Costs
of Onboard Refueling Controls
(Millions of Dollars[1])
Undiscounted

Calendar Year	LDGVs	LDGTs	HDGVs	Total Costs
1988	38.30	17.60	2.10	58.00
1989	26.00	11.00	2.70	39.70
1990	126.90	57.00	4.70	188.60
1991	126.90	56.55	4.65	188.10
1992	126.90	55.95	4.60	187.45
1993	125.75	54.70	4.65	185.10
1994	124.65	53.35	4.70	182.70

[1] Rounded to the nearest 0.05 million.

Table 9

Aggregate Incremental Costs
of Onboard Refueling Controls
(Millions of Dollars[1])
Discounted 1990

Calendar Year	LDGVs	LDGTs	HDGVs	Total Costs
1988	46.35	21.30	2.55	70.20
1989	28.60	12.10	3.00	43.70
1990	126.90	57.00	4.70	188.60
1991	115.35	51.40	4.20	170.95
1992	104.85	46.25	3.80	154.90
1993	94.50	41.10	3.50	139.10
1994	85.10	36.45	3.20	124.75
Total	601.65	265.60	24.95	892.20

[1] Rounded to the nearest 0.05 million.

of the manufacturing year, so the only significant negative impact on manufacturers' cash flow would come from the fixed costs, i.e. systems engineering, certification and facilities modifications. Although these costs would eventually be recovered, they would likely be incurred during the two years prior to the effective model year of the regulations, when there would be no directly offsetting revenues received. Assuming that all of the fixed costs would be incurred in the two years prior to the effective date of the standards, the average cost per year would be less than $50 million. This represents less than one-half of one percent of the cash outlay made by the domestic industry during 1980 and 1981 for modernization and downsizing.[11]

The effect of these regulations on sales and employment is also expected to be minimal. The first price increase to consumers is only 0.1 to 0.2 percent of the average cost of a new vehicle for LDVs, LDTs and HDGVs. By contrast, the annual price increases for new vehicles have been many times these percentages in recent years, even in times of very low inflation. The impact of such increases on consumer demand for vehicles is commonly expressed in terms of the price elasticity of demand, ie. the reduction in sales corresponding to an increase in price. EPA has determined a price elasticity of demand of -1.0 for LDVs & LDTs and -0.9 to -0.5 (average of -0.7) for HDGVs.[1,12] The resulting decrease in demand would thus be -.1 to -.2 percent for LDVs, LDTs and HDGVs. However, a real question arises as to whether it is appropriate to apply this price/demand model to such small price increases. Thus, although it is conceivable that consumer demand, and consequently sales, could be affected slightly, it is highly unlikely and not measurable. Accordingly, the impact on employment in the auto industry should also be minimal. In fact, some additional employment in the manufacture of onboard control hardware is likely. This employment would occur in the traditional auto industry but would also extend to suppliers of activated carbon, vapor lines, and other components.

Onboard controls could result in a slight decrease in the demand for gasoline, due to the fuel recovery credits. However, the savings involved are small in comparison to the projected gains in fuel economy during the period in question without the credits, or to the normal fluctuations in consumer demand due to other factors. A slight reduction in demand for gasoline could in turn result in a slight decrease in the demand for imported oil and perhaps an improvement in the nation's balance of trade, but this would likely be offset by the price increase on imported vehicles. Any effect on employment in the petroleum industry would also be negligible.

In conclusion, the overall socioeconomic impact of these regulations is expected to be minimal. Barring a significant recession in the late 1980'S auto and truck manufacturers are

expected to have no trouble underwriting the capital investment required. Vehicles sales should not be impacted measurably, and employment in the automotive and related industries may increase slightly. These regulations are not expected to have any net effect on the balance of trade.

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3.0 ENVIRONMENTAL IMPACT: Ozone Air Quality

I. Introduction

This chapter evaluates the effects on ambient air quality associated with implementing a 0.10 gram per gallon (g/gal) refueling emission standard for light-duty vehicles, light-duty trucks, and heavy-duty vehicles that use gasoline fuel. The proposed refueling standard is assumed to take effect with the 1990 model year. The following section serves as the background for the remainder of the chapter. It includes a brief characterization of the emissions associated with the refueling process, a discussion of those emissions which are potentially controllable with onboard control technology, and the interaction between refueling emission controls and concurrent reductions in excess evaporative emissions from motor vehicles. The last section evaluates the relative effect of controlling refueling and excess evaporative emissions on ambient ozone levels in selected urban areas currently in violation of the National Ambient Air Quality Standard (NAAQS) for this pollutant. The actual adverse effects of ozone on man and the environment will not be described in this section, since these effects have been fully documented elsewhere.[1,2]

In general, this chapter has a relatively narrow focus. The ambient air quality analyses contained herein have a much more limited range than the emission inventory analyses presented in Volume 1 of the draft Regulatory Impact Analysis (draft RIA). The analyses of this chapter examine only those non-California urban areas that were in non-attainment status for the ozone standard on the basis of 1983 design values. A detailed evaluation of various national emission reduction scenarios is contained in the first volume of the draft RIA, and is not repeated here. Also, this chapter does not address the carcinogenic potential of gasoline vapors. Again, this topic is discussed in the first volume of the draft RIA. Readers wishing to obtain further information on the aforementioned subjects should see the appropriate sections of this document.

It is important to note that the following analysis was done to estimate trends in ozone attainment for the group of urban areas in the sample. It uses VOC emission inventory data from EPA's National Emission Data System and not city-specific inventory data. In addition, an up-to date assessment of the implementation of stationary source regulations for each area was not made. Therefore, the analysis should be viewed as indicating probable changes in the magnitude of the ozone nonattainment problem and <u>not</u> as a prediction of attainment/nonattainment for specific urban areas.

II. General Description of the Emissions Associated with Refueling and the Use of Onboard Controls

A. Refueling Emissions

Gasoline vapors are composed of various hydrocarbon (HC) compounds. During the vehicle refueling process, these vapors are emitted from a variety of sources. The majority of the refueling emissions (i.e., about 90 percent) are HC vapors displaced from the vehicle's fuel tank by the incoming gasoline. The mass of vapor which escapes per unit of gasoline dispensed, or the emission factor, is dependent on several variables, including: (1) the temperature of the dispensed fuel, (2) the difference between the temperature of the dispensed fuel and the fuel tank, and (3) the volatility of the fuel.[3] These highly concentrated vapors are emitted from the vehicle's fillneck directly into the breathing zone of the person performing the refueling operation.

In addition to displacement losses from the vehicle tank, there are two secondary sources of emissions associated with refueling. The first is spillage, due to "splash back" from the fill pipe or the escape of some liquid from the dispensing nozzle when withdrawn from the fill pipe. The second is the escape of vapor from the vent of the service station's underground tank following refueling. As fuel is pumped into the vehicle's fuel tank, ambient air is drawn into the service station's tank through its tank vent. This "fresh" air causes fuel in the tank to evaporate until an equilibrium concentration is reestablished between the vapor and the liquid. As this process takes place, the total volume of the ingested air in the underground tank increases somewhat, and the excess volume is emitted from the vent in the form of HC emissions. These latter two sources each account for about 5 percent of the total emissions associated with the refueling process, as described in the first volume of the draft RIA.

The total refueling emission factor is expressed as the mass of HC emitted per gallon of dispensed fuel (g/gal), and varies from region to region due to differences in temperatures and fuel volatility. As an example, using national average temperature values and national average estimates of future volatility levels based on historic trends, the total emission factor for all three sources is 6.6 g/gal.[3]

B. Emissions Potentially Controllable by Onboard Technology

Onboard controls function during a refueling operation by sealing the vehicle's fillneck and then routing the displaced vapors to a storage canister, where the HC molecules are adsorbed onto the surface of activated charcoal. When the vehicle's engine is started, fresh air is drawn through the

canister to purge the HC molecules from the charcoal. The resulting vapor is transferred to the fuel metering system and subsequently burned in the engine. Tests have shown that properly designed and operating onboard systems are capable of controlling about 99 percent of the displacement vapors.[4] (The control effectiveness value was revised upward from the 97 percent used in the gas marketing study based on more recent test data.) Of those emissions not captured, nearly all escape from the fillneck (i.e., 95 percent). The remainder (i.e., 5 percent appear to be emitted from the canister, which typically is located in the engine compartment.

Onboard control technology will also have the effect of eliminating one of the two secondary sources of emissions associated with refueling mentioned previously, that of "splash back." These emissions, which result from the spillage and subsequent evaporation of liquid gasoline, should be significantly reduced through the design of the proposed test procedure. The primary cause of fuel spillage is dispensing of the fuel at too rapid a rate, relative to what the vehicle fillneck is able to accept. The proposed test procedure specifies a maximum fuel dispensing rate of 10 gallons per minute. The draft regulations accompanying today's proposal specify this same maximum fuel flow rate as an in-use standard, as well as being part of the test procedure. Since, to be able to meet the proposed standard, no fuel spillage can be tolerated during certification testing of the onboard system, EPA believes that spillage due to high fueling rate will be eliminated through fuel flow rate restrictions and standardized design of fuel delivery nozzles. Of course, spillage from such causes as nozzle malfunctions will not be affected by the new procedures. The other secondary source of refueling-related emissions, emptying losses from service stations' underground storage tanks, will not be affected by onboard control technology.

The overall in-use efficiency of capturing displacement vapors will be somewhat less than 99 percent, due to the effects of tampering on some vehicles. Tampering is primarily expected to take the form of removal or disconnection of the canister. In such instances, the displacement losses revert to the uncontrolled level, but are re-oriented spatially. With tampered systems, the majority of the vapors would be emitted at the location of the missing or disconnected canister, rather than from the fillneck into the breathing zone of the person dispensing the fuel.

An issue that is intimately associated with the implementation of an onboard refueling standard is the interaction between the requisite control technology and the elimination of excess evaporative emissions from motor vehicles. Evaporative emissions are primarily a combination of breathing losses from the vehicle's fuel tank, due to diurnal

temperature changes, and losses from the carburetor bowl, fuel lines, and fuel tank that occur as the result of residual heat from the engine and exhaust system after the engine is turned off. Presently, gasoline-fueled vehicles must be certified to certain evaporative emission standards prior to mass production and sale. The control technology used to reduce evaporative emissions to the required levels is similar in design and function to that described above for onboard refueling hardware (i.e., carbon canisters). However, data from EPA's emission factor program indicate that many in-use vehicles fail to comply with the applicable standards. The principle cause of these failures is that in-use fuel typically has a higher volatility than the fuel specified for certification testing. The increased amounts of evaporative HC caused by higher in-use volatilities cannot be adsorbed by current charcoal canister systems. These additional HC vapors escape into the atmosphere as excess evaporative emissions.

The Agency is presently considering a variety of strategies aimed at assuring in-use compliance with evaporative emission standards. While no decision has been made, one alternative is to make relatively simple changes to the current evaporative emission test procedures and to increase the volatility of certification fuel to be more representative of in-use levels (i.e., certification fuel volatility equals in-use fuel volatility). These revisions basically would result in larger canisters and different purge rates. Since onboard technology includes a larger charcoal canister than is necessary to control evaporative emissions, even assuming the revision of test fuel volatility, and because refueling normally would not coincide with the occurrence of evaporative emissions, it is possible to control excess evaporative losses by integrating the requisite controls with the refueling control system at little additional cost. In order to illustrate the effects of such a program, the analyses presented in the remainder of this chapter will include a scenario that combines the control of refueling emissions plus excess evaporative emissions, in addition to a scenario that evaluates only the control of refueling emissions.

III. Air Quality Analysis

A. Selection of Areas for Modeling

The NAAQS for ozone requires that the fourth highest daily maximum one-hour measured concentration not exceed 0.12 parts per million (ppm) in any three-year period. On the basis of ozone air quality monitoring data collected in 1982, 1983, and 1984 (or 1983 design values), which were the most recent complete data available, there are 73 urban areas with measured air quality above this standard.[5] Twelve of these 73 non-attainment areas were located in California. As already discussed, Stage II vapor recovery systems are currently being

used in nearly all of California, and it is unclear whether these systems will continue to be used or if they will be discontinued in favor of onboard controls. Because of this uncertainty, only the 61 non-California urban areas listed in Table 1 are included in the air quality analysis. This simplifies the analysis without affecting the resulting conclusions. (The specific design values contained in Table 1 are further discussed in Section III.B.6.)

B. Air Quality Methodology

Future ambient ozone concentrations in specific urban areas were estimated using the Empirical Kinetic Modeling Approach (EKMA). This model utilizes a series of ozone isopleths depicting downward maximum ozone concentrations as an explicit function of initial non-methane hydrocarbon (NMHC) and oxides of nitrogen (NOx) concentrations and as implicit functions of a number of emissions and meteorological characteristics. Differences between initial and subsequent emissions as well as changes in concentrations of pollutants transported into the modeled area are then simulated to estimate changes in maximum ozone. It should be noted that EKMA, as used by EPA in this analysis, is a nationwide-average model. In other words, the only city-specific information used as input data for the model are the base-year ambient ozone concentrations (design values) and the emission inventories from which future concentrations are projected, and the NMHC:NOx ratios. Meteorological conditions and other input data are held constant for all the urban areas modeled. References 6 and 7 contain additional information on the use of EKMA.

The initial, or base-year, emission inventories used in the model are based on the information contained in EPA's National Emissions Data System (NEDS), which is compiled by the Agency's Office of Air Quality Planning and Standards (OAQPS). The NEDS inventory includes emissions from both stationary and mobile sources. The most recent emissions compilation at the time of this analysis was for calendar year 1983, and is referred to as the 1983 base-year inventory. Stationary source inventories for any future year are computed by the model using anticipated growth and retirement rates, along with estimates of emission control efficiency. Similarly, future inventories are constructed for mobile sources using the emission factor ratios (base-to-future years) and annual compound VMT growth rates for each vehicle class, derived from EPA's MOBILE3 Emission Factor Model and MOBILE3 Fuel Consumption Model, respectively.

Table 1

61 Non-California Urban Ozone Non-Attainment Areas and Associated Design Values (ppm)

Area	82-84 DVs	EKMA DVs
EPA Region 1		
Boston Metropolitan Area	0.19	0.18
Greater Metropolitan Connecticut	0.23	0.18
New Bedford, MA	0.19	0.19
Portland, ME	0.15	0.10
Portsmouth-Dover-Rochester, NH-ME	0.13	0.09
Providence, RI	0.16	0.15
Springfield, MA	0.19	0.17
Worcester, MA	0.14	0.12
EPA Region 2		
Atlantic City, NJ	0.19	0.15
New York Metropolitan Area	0.23	0.24
Vineland-Millville-Bridgeton, NJ	0.14	0.14
EPA Region 3		
Allentown-Bethlehem, PA	0.15	0.14
Baltimore, MD	0.17	0.17
Erie, PA	0.13	0.13
Harrisburg-Lebanon-Carlisle, PA	0.13	0.13
Lancaster, PA	0.14	0.09
Philadelphia Metropolitan Area	0.18	0.20
Pittsburgh, PA	0.14	0.14
Reading, PA	0.13	0.13
Richmond-Petersburg, VA	0.14	0.14
Scranton-Wilkes Barre, PA	0.13	0.13
Washington, DC-MD-VA	0.16	0.17
York, PA	0.13	0.13
EPA Region 4		
Atlanta, GA	0.17	0.17
Birmingham, AL	0.15	0.15
Charlotte-Gastonia-Rock Hill, NC-SC	0.13	0.13
Chattanooga, TN-GA	0.13	0.13
Huntington-Ashland, WV-KY-OH	0.14	0.14
Louisville, KY-IN	0.15	0.15
Memphis, TN-AR-MS	0.13	0.13
Miami-Hialeah, FL	0.13	0.13
Nashville, TN	0.13	0.13
Tampa-St. Petersburg-Clearwater, FL	0.13	0.13

Table 1 (cont'd)

Area	82-84 DVs	EKMA DVs
EPA Region 5		
Akron, OH	0.13	0.13
Canton, OH	0.13	0.13
Chicago Metropolitan Area	0.20	0.25
Cincinnati Metropolitan Area	0.15	0.17
Cleveland, OH	0.14	0.14
Dayton-Springfield, OH	0.13	0.13
Detroit, MI	0.14	0.14
Grand Rapids, MI	0.13	0.13
Indianapolis, IN	0.13	0.13
Milwaukee Metropolitan Area	0.17	0.17
Muskegon, MI	0.14	0.14
EPA Region 6		
Baton Rouge, LA	0.17	0.17
Beaumont-Port Arthur, TX	0.21	0.21
Brazoria, TX	0.14	0.14
Dallas-Fort Worth Metropolitan Area	0.16	0.16
El Paso, TX	0.17	0.17
Galveston-Texas City, TX	0.17	0.17
Houston, TX	0.25	0.25
Lake Charles, LA	0.15	0.15
Longview-Marshall, TX	0.15	0.15
New Orleans, LA	0.15	0.15
San Antonio, TX	0.14	0.14
Tulsa, OK	0.13	0.13
EPA Region 7		
Kansas City, MO-KS	0.14	0.14
St. Louis, MO-IL	0.17	0.17
EPA Region 8		
Denver Metropolitan Area	0.14	0.14
Salt Lake City-Ogden, UT	0.15	0.15
EPA Region 9		
Phoenix, AZ	0.15	0.15

The specific stationary source estimates and assumptions used in the model for this analysis are the same as those that were used in EPA's report on in-use fuel volatility and evaporative emissions (hereafter referred to as the volatility study).[8] Because these model inputs are fully described in that document, they are not repeated here. The volatility study also evaluated baseline and excess evaporative control scenarios that are identical to those considered in this chapter. Rather than repeat the detailed discussion of the mobile source inputs for these scenarios, only a few of the key features of that analysis, along with the basic inputs used to model the onboard control scenario evaluated here, are described below.

1. Fuel Volatility

Under the baseline scenario, the Reid vapor pressure (RVP) of in-use fuel is the maximum summertime value (11.5 pounds per square inch) recommended by the American Society for Testing and Materials (ASTM) in "Class C" areas, which include most areas of the country with significant ozone air quality problems.[8] This value was chosen because nearly all ozone NAAQS violations in these locations occur during the summertime and, based on current fuel volatility trends, it is expected that this RVP level will be reached by the time onboard controls enter the marketplace. (In fact, this level is already being exceeded in some areas, at least at times.) The RVP of the certification fuel for the baseline scenario is the currently specified value of 9.0 psi. Under the control scenarios, the RVP of in-use fuel is again 11.5 psi. However, the RVP of certification fuel is assumed to be revised to equal that of in-use fuel.

2. Fuel Temperatures

The mass of gasoline vapors displaced from the vehicle's fuel tank is highly dependent on the temperature of the dispensed fuel, as well as the temperature of the fuel already in the tank. As mentioned with regard to fuel volatility, most ozone violations occur during the summer months. Therefore, national average summertime temperatures for the two fuel-related temperature parameters are appropriate when modeling ozone air quality. These values are 88.2°F and 78.8°F for fuel tank and dispensed fuel, respectively.[3]

3. Refueling Emission Factors

The refueling emission factor is composed of three parts: vehicle fuel tank displacement losses, spillage, and service station tank emptying losses. The amount of displacement vapors which escape from an uncontrolled vehicle during the refueling event are found by using the RVP and temperatures just described, along with the equation developed in an EPA

technical report that relates these parameters to displacement losses:[3]

Displacement losses =

$$= -5.909 - 0.0949(\Delta T) + 0.884(T_D) + 0.485(RVP)$$
$$= -5.909 - 0.0949(+9.4) + 0.884(78.8) + 0.485(11.5)$$

Where:

T_D = temperature of the dispensed fuel (°F),
$\Delta T = T_T - T_D$ = difference between the temperature of fuel already in the vehicle tank (T_T) and dispensed fuel, and
RVP = Reid Vapor Pressure of the dispensed fuel (psi).

The resulting value for the displacement losses component of the refueling emission factor is 5.7 g/gal.

As discussed in greater detail in reference [3], data on the frequency and magnitude of spillage losses are both scarce and widely variable. EPA has chosen to use 0.3 g/gal to represent the spillage portion of the refueling emission factor and 0.4 g/gal to represent the emptying losses. These values are taken from Volume 1 of the draft RIA. Summing these three components yields the uncontrolled refueling emission factor of 6.4 g/gal.

For vehicles equipped with onboard controls, two emission factors are used in the analysis, depending on whether the system is properly operating or has been tampered with. Tests of properly operating (non-tampered) systems have shown the capability to control 99 percent of the displacement losses.[4] As noted earlier EPA expects that implementing onboard controls will also serve to reduce spillage losses. However, since the amount of spillage which will be controlled is unclear at this time, EPA has taken the more conservative position of assuming no reduction in spillage. Therefore, adding the spillage and emptying losses, the resulting non-tampered emission factor is 0.8 g/gal.

Since there are no externally visible changes to a vehicle equipped with an onboard control system, the rate of tampering with such systems is assumed to be no more frequent than that occurring with current evaporative controls, and will take only the forms of removal or disconnection of the storage canister. When this occurs, emissions would revert to their uncontrolled level (i.e., 6.4 g/gal). MOBILE3 accounts for the effects of tampering by utilizing this uncontrolled emission factor with appropriate tampering rates (see below).

It should be noted that the uncontrolled emission factor used to examine ambient ozone air quality differs slightly from that used to evaluate other health effects (i.e., 6.4 versus 6.6 g/gal). This is the result of using different volatility and temperature data to estimate displacement losses for the two analyses. As mentioned above, ozone violations are primarily a summer problem, so the emission factor for the air quality analysis is based on national summertime average values. In contrast, the emission factor for the health effects analysis was derived using national annual average values since, unlike ozone violations, these phenomena are not restricted to certain areas of the country or to a specific season. Since fuel volatility and fuel temperatures vary over the course of the year, the two resulting emission factors are not equal. In any event, it should be noted that the difference in the emission factors is only about 3 percent.

4. Tampering Rates

In the onboard control scenario, the tampering rates used in MOBILE3 for removal and disconnection of the evaporative emissions storage canister are also used to reflect refueling canister tampering. It should be noted that the tampering rates contained in the original MOBILE3 were revised in the volatility study to reflect later information from EPA's in-use surveillance programs.[8] The inclusion of these 1985 survey data had the effect of slightly increasing the tampering rates, relative to the original MOBILE3 tampering rates. These new rates, which vary as a function of vehicle mileage, have been used in this analysis. The tampering rates used in this analysis for LDVs and LDTs, respectively, are about 2.5 and 6 percent at 50,000 miles, and about 6 and 9 percent at 100,000 miles.[8]

It should also be noted here that with the use of a liquid seal, which EPA anticipates will be the dominant approach, the vehicle fillneck is no different with than without an onboard control system. In fact, the incorporation of onboard technology with the liquid seal should be virtually transparent to the vehicle owner/operator, thus presenting no real incentive to tamper. Thus, it is assumed that whatever tampering will occur as a result of the implementation of onboard controls will be limited only to the removal or disconnection of the canister, as noted above. This would not be the case with Stage II control systems, or with onboard control systems using mechanical fillneck seals.

5. Inspection and Maintenance Program

The exhaust emission factors used in the air quality analysis assume the existence of Inspection and Maintenance Programs (I/M) in each of the non-attainment areas throughout the projection period. This assumption has the effect of

slightly lowering the average emission factors assigned to those vehicles subject to I/M. This assumption was made in consideration of the fact that most of the high-population areas among the 61 non-California urban areas modeled either have I/M programs in effect already, or have such programs scheduled to go into effect in the near future. In addition, I/M programs are a fundamental component of the Agency's recently announced four-phase ozone compliance strategy (see the introduction to this section).

6. Design Values and Base Year Inventories

As noted earlier, the design values and inventory projections in this chapter use 1983 as the base year. More specifically with regard to design values, two different types have been used as part of this analysis. The design values briefly discussed in Section III.A., and used in the determination of non-attainment status, are based on the 1982, 1983, and 1984 air quality monitoring data without modification. These values are shown in Table 1 under the heading "82-84 DVs" and represent the fourth highest daily maximum hourly ambient ozone concentrations measured in the three years of monitoring data examined.

Previous ozone air quality analyses have used similarily defined values as a necessary input for EKMA. In this application, the value is interpreted as the ambient ozone concentration in the base year. However, the air quality analyses for this chapter include a refinement which leads to the development of a second set of "design values" being used to represent the base year ambient concentrations. These values are also shown in Table 1, under the heading "EKMA DVs."

This second set of design values reflect modifications that attempt to take into account the transport of ozone. This is accomplished by a computer program known as MASH (Multiple Airshed). MASH uses wind directions and the times that ozone exceedances (i.e., one-hour concentrations in excess of the 0.12 ppm NAAQS) occur to determine whether an exceedance is predominantly the result of emissions originating in the local area, or of emissions originating in a nearby major metropolitan area upwind. It then assigns the measured ozone levels to either the upwind metropolitan area or the local area as a function of selected criteria.[5] In regions where ozone transport is significant (e.g., the northeastern part of the country), this process tends to lower the design values in smaller cities or SMSAs and to raise the design values in the larger metropolitan areas. These MASH-processed design values are intended for use in ozone air quality modeling, and are not appropriately used in determining attainment/non-attainment status.

It should also be noted that there is relatively little difference in the two sets of design values, with the "82-84 DV" and "EKMA DV" being equal for 46 of the 61 areas modeled. Of the 15 areas where the application of the MASH program led to a change in the design value, the value used for input to EKMA is lower than the unmodified value in 10 of the areas and higher in five of them. The areas with differences between the two values are concentrated in the Northeast and along the central East Coast (EPA Regions 1, 2, and 3), where many of the SMSAs and metropolitan areas are contiguous. The greatest increase in design value resulting from the MASH program occurs for the Chicago Metropolitan Area. The increase of 0.05 ppm represents a 25 percent increase over the unmodified value.

In addition to the design values, EKMA also requires NMHC inventories and NMHC:NOx ratios. As noted above, the inventories are developed as part of the National Emission Data System (NEDS).

To model air quality in a given future projection year, a number of assumptions must be made about control technology, control efficiency, and growth rates. For example, modeling the air quality impact of the proposed refueling emission standard involves the calculation of emission factors for refueling emissions from all gasoline-fueled mobile sources (light-duty vehicles and trucks and heavy-duty vehicles), both with and without onboard refueling controls. By holding other parameters constant in both cases (i.e., growth rates, exhaust emission standards, stationary source control efficiences and growth rates), the effect of the proposed refueling emission standard on ozone air quality can be projected.

7. Stationary Source RACT and the FMVCP

The modeling of future NMHC inventories and ambient ozone concentrations involves looking at emissions from both mobile and stationary sources. For mobile sources, the key inputs include the emission factors (as calculated by MOBILE3) and vehicle miles travelled (VMT) growth rates. The emission factors for each vehicle/engine class vary by model year, reflecting the impact of the Federal Motor Vehicle Control Program (FMVCP), under which increasingly stringent exhaust and evaporative emission standards have been established.

EPA has developed an extensive data base on the in-use performance of mobile source emission control technology. Based on this information, the Agency has a high degree of confidence in the emissions reductions projected to result from standards established under the FMVCP. Even when coupled with projected VMT growth, the FMVCP gains net reductions in the mobile source portion of future NMHC inventories into the 1990s.

In the case of stationary sources, the two main inputs required for modeling future emissions are growth rates and control efficiencies. Stationary source NMHC emissions are divided into six major categories in EPA's models.[8,9] For some stationary sources, EPA has defined "reasonably available control technologies" (RACT) and issued control technology guidelines (CTGs). RACT-based emission controls, for those categories covered by CTGs, are required to be included as part of each state's plan for attaining the NAAQS for ozone.

Previous EPA modeling results have always indicated decreasing emission inventories and improving air quality at least through the mid and late 1980s. Nonetheless, the most recent ambient ozone monitoring data indicate that the projected improvements indeed may not be occurring. It is widely accepted that the mobile source portion of the inventory will continue to decline as a result of fleet turnover, with an increasing fraction of the national fleet being comprised of vehicles subject to the stringent emission standards taking effect in the early and mid 1980s. Since the FMVCP continues to yield emission reductions, but monitoring data suggest the expected improvement in ozone air quality is not occuring, the assumptions used in previous EPA analyses concerning the efficiency and timing of stationary source RACT control appear to have been overly optimistic.

The Agency knows that some RACT-based emission reductions had already occurred as of the base year; what is not known is what fraction of sources subject to RACT actually were controlled. Nor is it known, because of various practical constraints on the application of RACT controls, what fraction of the sources subject to RACT can actually be expected to be controlled in the near future. Without this information, the amount of additional RACT-based control still available is also uncertain. EPA is attempting to resolve these questions as part of the abovementioned review of RACT controls. Until EPA has better data available on the actual rate of implementation and control efficiency of stationary source RACT, the "baseline" scenario for this analysis assumes no RACT-based stationary source emission reductions are assumed to occur after the base year.

C. Ambient Air Quality Results

Tables 2 and 3 present the results of the EKMA-based air quality projections for the 61 urban areas currently in non-attainment of the ozone NAAQS. The information in Table 2 is also presented graphically in Figure 1. Two measures of air quality in various calendar years are shown: total NMHC emissions and the number of non-attainment areas. Each table displays the model's output for the scenarios analyzed: baseline (FMCVP only), control of excess evaporative emissions only, and control of both refueling and excess evaporative

emissions. A comparison of the results for the three scenarios indicates the incremental effects of implementing control of excess evaporative emissions and then refueling controls.

Before discussing the results for the control scenarios, it is interesting to briefly examine the projections for the baseline scenario in each table. Generally, the results for this scenario show significant improvements occur primarily in response to the stationary and motor vehicle emission standards which already have been promulgated. However, Table 3 shows that a significant number of violations and non-attainment areas continue to exist throughout the projection period. It also appears that by about the mid to late 1990s, the trend toward decreasing ambient ozone levels will be reversed, and air quality will worsen steadily thereafter. The continued number of non-attainment areas, in addition to the projected deterioration in air quality, indicates the need for additional HC reductions to help attain and maintain the NAAQS for ozone across the nation.

Regarding the effects of the control scenarios, Table 2 shows that as onboard-equipped vehicles comprise an increasing percentage of the motor vehicle fleet over time, reductions in the non-methane hydrocarbon inventory due solely to refueling controls change from 105,000 tons (about 1.5 percent) in 1995, to 179,000 tons (about 2.1 percent) in 2010. If reductions in excess evaporative emissions are also included, the reductions are approximately double those amounts.

Based on the air quality modeling results presented above, and in Tables 2 and 3 and Figure 1, it appears that the implementation of onboard refueling standards for gasoline-fueled LDVs, LDTs, and HDVs can provide significant long-term benefits in helping to achieve and maintain the ozone NAAQS.

Table 2

Total Non-Methane Hydrocarbon Emissions for 61 Urban Areas (x1000 Tons)

Scenario	1990	1995	2000	2010
Baseline (FMVCP only)	6961 (14.2)[1]	6926 (14.6)	7256 (10.5)	8420 (+3.8)
Excess Evap Control[2]	6958 (14.2)	6823 (15.9)	7074 (12.8)	8160 (+0.1)
Refueling & Excess Evap Control	6931 (14.6)	6718 (17.2)	6928 (14.6)	7981 (1.6)

[1] Figures in parentheses represent the percent change (decrease, unless otherwise noted), relative to the 1983 base-year inventory of 8,111.6 tons for the 61 areas.

[2] No control of refueling.

Figure 1

TOTAL NMHC INVENTORIES FOR
61 URBAN NON-ATTAINMENT AREAS

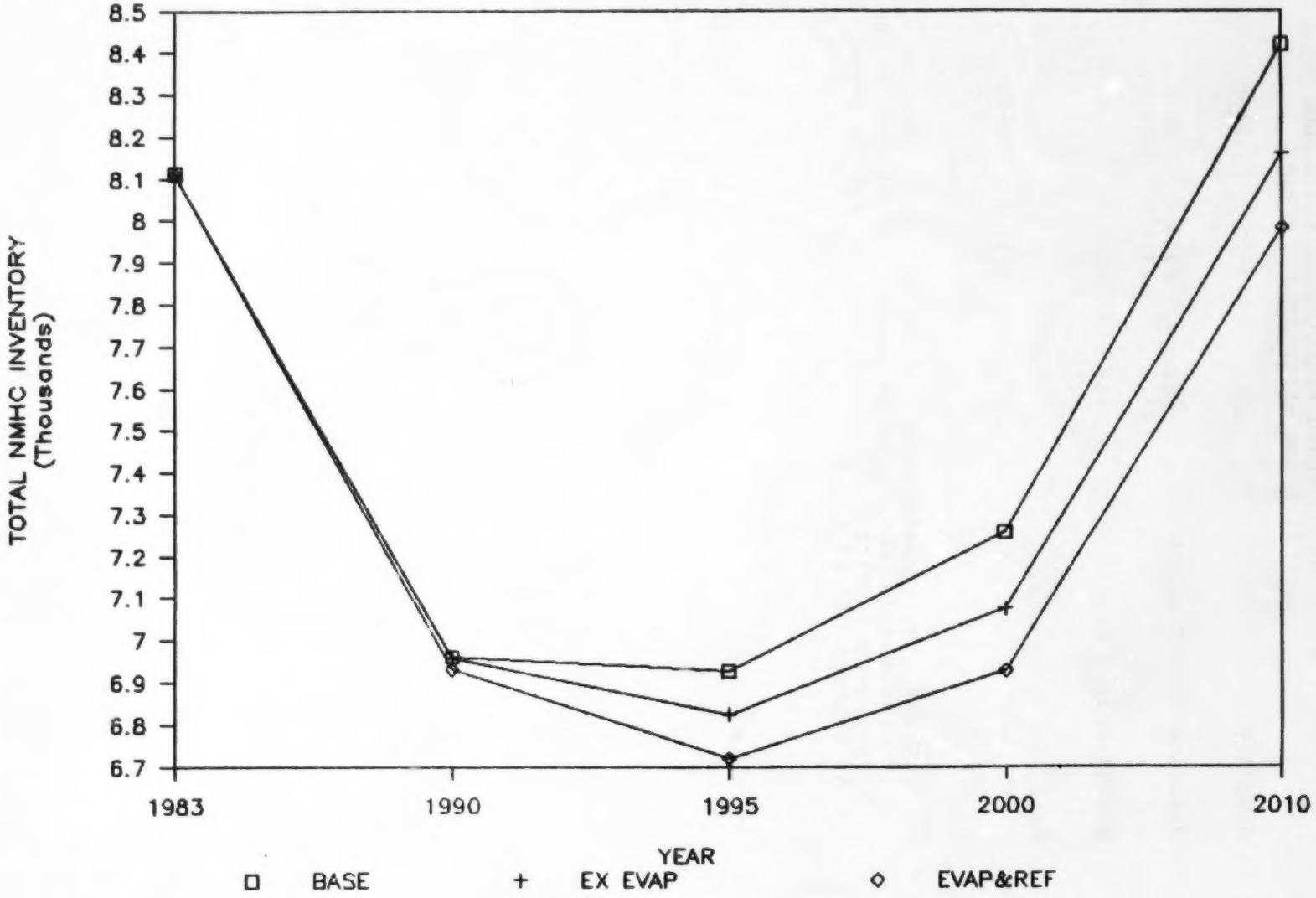

Table 3

Estimated Number of Non-California
Urban Ozone Non-Attainment Areas

Scenario	1990	1995	2000	2010
Baseline (FMVCP only)	47	46	48	55[1]
Excess Evap Control[2]	47	44	47	53
Refueling & Excess Evap Control	46	40	44	51

[1] Only the 61 non-California areas listed in Table 3 were modeled. Additional areas are likely to be in non-attainment in 2010 under the "Baseline (FMVCP only)" scenario.

[2] No control of refueling.

REFERENCES FOR CHAPTER 3

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